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Assessment of the environmental impact of the cleaning stages of food manufacturing processes using Life Cycle Assessment: the example of milk protein separation via filtration

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Food manufacturing processes require frequent cleaning to assure the quality of the end product and to maintain a faultless mode of operation of the equipment. However, the environmental impact of such cleaning steps, which are known to consume large amounts of water, energy and chemicals, is rarely assessed.

The objective of this work therefore is to quantify the environmental impact of the cleaning stages of an industrial food manufacturing process consisting of milk protein separation using Life Cycle Assessment (LCA) and to demonstrate the application of LCA for improvement of the process design.

The inventory of the foreground system was established based on a collaborative project between several research institutes and industrial partners. Generic data was derived from the Ecoinvent V2.2 data base and a comparative attributional Life Cycle Analysis (LCA) was carried out using IMPACT 2002+ and the Simapro 8.0 software.

The environmental impact of the cleaning stages corresponds to 31% of the impact of the entire process, compared to 65% for the production phase, 3% for the transport and 1% for the equipment. To reduce the environmental burden of the cleaning stages two different strategies have been applied: (C1) reutilization of the process water from the reverse osmosis used for the concentration of the milk proteins as rinsing water and (C2) rationalization (i.e. less frequent renewal) of the cleaning solutions. Strategy C1 requires supplementary equipment for treatment of the permeate produced by the reverse osmosis thus generating an additional impact. Nonetheless, it allows a significant reduction of both the water consumption by 316m³/day (583m³ milk treated/day) and the aquatic ecotoxicity impact of the entire process by 26%, mainly due to a lesser utilization of the potable water network. The second strategy (C2) decreases the environmental impact of the entire process by less than 10%. Both strategies could be implemented simultaneously thus leading to an even more considerable improvement of the environmental performance. Note that the environmental impact is generally underestimated due to incomplete data regarding the cleaning agents, missing impact factors for certain chemical compounds and the exclusion of the water volume. Besides, the economic impact of the very time intensive cleaning procedures is not addressed at this stage.

This work demonstrates the usefulness of LCA for decision-making on more efficient process design and it emphasizes to increase efforts for improving the cleaning operations of food processes to reduce their impact on the environment.

Type of presentation: oral presentation

Highlight 1: The environmental impact of the cleaning stages of food manufacturing processes is considerable.

Highlight 2: Relatively simple measures can meaningfully improve the environmental performance of the cleaning stages of food manufacturing processes.

Highlight 3: Life Cycle Assessment (LCA) is a useful tool in the decision-making for more efficient process design.

Keywords:

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